WHAT IS CLAIMED IS:

1. A method comprising the steps of:

a) dispersing carbon nanotubes in an acidic medium to form dispersed carbon nanotubes with substantially exposed sidewalls; and

b) functionalizing the dispersed carbon nanotubes by covalently attaching functional groups to their substantially exposed sidewalls to yield sidewall functionalized carbon nanotubes.

2. The method of Claim 1, wherein the carbon nanotubes are selected from the group consisting of single-wall carbon nanotubes, double-wall carbon nanotubes, multi-wall carbon nanotubes, small diameter carbon nanotubes, and combinations thereof.

3. The method of Claim 1 or 2, wherein the acid medium comprises a superacid.

4. The method of Claim 1 or 2, wherein the acid medium comprises an oxoacid selected from the group consisting of H_2SO_4, H_3PO_4, $HClO_4$, and HNO_3, and combinations thereof.

5. The method of Claim 1 or 2, wherein the acid medium comprises H_2SO_4.

6. The method of Claim 1-4, or 5, wherein the acid medium comprises a persulfate species.

7. The method of Claim 1-5, or 6, wherein the step of functionalizing involves a functionalizing agent selected from the group consisting of carbocations, halonium ions, metal cations, carbon radicals, halogen radicals, hetero-atom radical species, metal-based radicals, dipolarophiles, and combinations thereof.

8. The method of Claim 1-6, or 7, wherein the step of functionalizing involves a diazonium species.

9. The method of Claim 8, wherein the diazonium species is generated *in situ* by reaction of an aniline species with a nitrite species.

10. The method of Claim 8, wherein the diazonium species is provided as a diazonium salt.

11. The method of Claim 8, wherein the diazonium species is generated from a triazene precursor.

12. The method of Claims 1-10, or 11 further comprising at least one post-processing step selected from the group consisting of diluting, filtering, washing, drying, and combinations thereof.

13. The method of Claims 1-10, or 11 further comprising the steps of:

a) isolating the sidewall functionalized carbon nanotubes from the acidic medium by filtering to yield isolated sidewall functionalized carbon nanotubes; and

b) resuspending the isolated sidewall functionalized carbon nanotubes in a solvent.

14. The method of Claim 13, wherein the solvent is water.

15. The method of Claims 1-13, or 14, wherein the functionalized carbon nanotubes have at least about 1 functional group per every 100 carbon nanotube carbons.

16. A method comprising the steps of:

a) dispersing single-wall carbon nanotubes in a superacid medium to form a dispersion;

b) adding aniline species and a nitrite species to the dispersion to form a reaction mixture; and

c) reacting the reaction mixture to form functionalized single-wall carbon nanotubes.

17. The method of Claim 16, wherein the single-wall carbon nanotubes have been oxidatively treated.

18. The method of Claim 16 or 17, wherein the single-wall carbon nanotubes are homogeneous in a characteristic selected from the group consisting of length, diameter, chirality, and combinations thereof.

19. The method of Claims 16-17, or 18 further comprising a step of filtering the dispersion to remove any large particles.

20. The method of Claims 16-18, or 19, wherein the superacid medium is selected from the group consisting of oleum, chlorosulfonic acid, triflic acid, and combinations thereof.

21. The method of Claims 16-19, or 20, wherein the aniline species comprises sulfanilic acid.

22. The method of Claims 16-20, or 21 further comprising a step of adding a radical source to the reaction mixture.

23. The method of Claim 22, wherein the radical source is selected from the group consisting of 2,2'-azo-*bis*-isobutyrylnitrile, benzoyl peroxide, di-tert-butylperoxide, and combinations thereof.

24. The method of Claims 16-22, or 23, wherein the step of reacting comprises heating and stirring.

25. The method of Claims 16-23, or 24 further comprising the steps of:

a) diluting the reaction mixture with water, subsequent to forming functionalized single-wall carbon nanotubes, to form a diluted reaction product mixture;

b) filtering the diluted reaction product mixture over a filter to isolate the functionalized single-wall carbon nanotubes; and

c) washing the isolated functionalized single-wall carbon nanotubes with a washing solvent to obtain washed functionalized single-wall carbon nanotubes.

26. The method of Claim 25, wherein the washing solvent is acetone.

27. The method of Claims 25 or 26 further comprising the steps of:

a) re-suspending the washed functionalized single-wall carbon nanotubes in water to form a re-suspension;

b) filtering the re-suspension to recover re-washed functionalized single-wall carbon nanotubes.

28. The method of Claims 16-26, or 27, wherein the functionalized single-wall carbon nanotubes have at least about 1 functional group per every 100 carbon nanotube carbons.